

What is claimed is:

1. A flexible biasing surface mold comprising:
 - a platform having a major surface;
 - 5 a first deformable member mounted on the platform and spaced from the major surface of the platform;
 - a second deformable member mounted on the platform and spaced from the major surface of the platform and from the first bendable member;
 - 10 a plurality of flexible strap members between the first and second deformable members and having a space between adjacent strap members, each support member having one end portion connected to the first deformable member and the opposite end portion connected to the second deformable member, and
 - 15 a force applying member acting on at least one of the deformable members to change distance between the major surface of the platform and a portion of the at least one of the deformable member.
- 20 2. The mold according to claim 1 further comprising:
 - a first pair of elongated rigid members each having an end portion mounted to the first deformable member and the opposite end portion mounted on the platform to position the first deformable member in a spaced relationship to the major surface of the platform,
 - 25 wherein the first pair of rigid members are spaced from one another, and
 - a second pair of elongated rigid members each having an end portion mounted to the second deformable member and the opposite end portion mounted on the platform to position the second
 - 30 deformable member in a spaced relationship to the major surface of the platform, wherein the second pair of rigid members are spaced from one another.

3. The mold according to claim 2 wherein the force applying member is a first force applying member connected to the first deformable member at a location between the first pair of rigid members, and further
5 comprising a second force applying member connected to the second deformable member at a location between the second pair of rigid members to change the distance between the second deformable member and the major surface of the platform.

10 4. The mold according to claim 3 wherein the first and second deformable members each having first surface facing the major surface of the platform and an opposite surface defined as a second surface, and the first end portion of each of the first pair of rigid members is pivotally mounted to the first surface of the first deformable member, and the first end portion of
15 each of the second pair of rigid members is pivotally mounted to the first surface of the second deformable member.

5. The mold according to claim 2 wherein the force applying member comprises:

20 a support member mounted between the platform and the first and second deformable members;

a first pull rod having an end portion connected to the first deformable member at a location between the first pair of rigid members and the other end defined as a second end portion of the first
25 pull rod connected to the support member;

a second pull rod having an end portion connected to the second deformable member at a location between the second pair of rigid members and the other end defined as a second end portion of the second pull rod connected to the support member, and

30 an elevator to move the support member toward the major surface of the platform to deflect the first and second deformable members.

6. The mold according to claim 5 wherein the first and second pull rods are slideably mounted in the support member, and the support member is captured between the first deformable member and the second end portion of the first pull rod, and the second deformable member and the second end portion of the pull rod.

7. The mold according to claim 3 wherein each of the strap members has a first surface facing the major surface of the platform and an opposite surface defined as a second surface and further comprising:

at least one wheel in the space between adjacent strap members;

a shaft interconnecting the wheels with the shaft between the first surface of the strap members and the major surface of the platform, and

a displacement system to move the wheels and strap members relative to one another from a first position with portions of periphery of the wheels above the second surface of the strap members to a second position with the periphery of the wheels below the second surface of the strap members.

8. The mold according to claim 7 wherein the shaft and the wheels comprise a first conveying roll, and the first conveying roll is one of a plurality of spaced conveying rolls wherein each of the conveying rolls includes a wheel in the space between adjacent strap members and a wheel on outer side of the outer strap members, and further comprising a motor operatively connected to the plurality of shafts wherein when the motor is energized the shafts and their respective wheels are rotated.

9. The mold according to claim 8 wherein the displacement system moves the platform to move the strap members from the first position to the second position.

10. The mold according to claim 9 wherein the shafts of the plurality of conveying rolls are mounted on a support structure and the platform is mounted for movement toward and away from the plurality of conveying rolls.

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11. The mold according to claim 8 wherein the displacement system comprises a support member between the strap members and the platform and at least one displacement device to move the support member and the shafts of the plurality of conveyor rolls toward and away from the strap members.

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12. The mold according to claim 11 wherein the support member has a first surface facing the platform and the at least one displacement device is mounted to the platform and to the first surface of the support member wherein the at least one displacement device moves the support member toward and away from the strap members to move the wheels and strap members from the first position to the second position, and the force applying members moves their respective deformable member toward the major surface of the platform.

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13. The mold according to claim 6 wherein at least one of the conveying rolls includes a unitary portion of shafts and wheels.

14. The mold according to claim 1 wherein the first and second deformable members are elongated members having a flat major surface and a long axis with the long axis of the first and second deformable members parallel to one another and the plurality of flexible strap members are each elongated members having a flat major surface and a long axis with the long axes of the strap members parallel to one another and normal to the long axis of the first deformable member.

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15. The mold according to claim 14 wherein at least one of the strap members is a laminate comprising a spring steel substrate having a plastic covering over at least the flat major surface of the at least one strap member.

5 16. The mold according to claim 3 wherein the first and second force applying members each comprise:

a biasing device mounted on the major surface of the platform,
and

10 a rod having first end portion connected to the biasing device
and an opposite end portion defined as a second end portion wherein
the second end portion of the rod of the first applying member is
connected to the first deformable member and the second end of the
rod of the second applying member connected to the second
deformable member.

15 17. The mold according to claim 16 wherein the biasing device is
selected from the group of electrically powered motors, stepper motors,
servomotors, fluid operated cylinders, rack and pinion arrangements and
crank mechanisms.

20 18. The mold according to claim 16 wherein the rod of the first and
second applying member is a telescoping rod and further comprising a first
plate having a slot mounted on the first surface of the first deformable
member between the first pair of rigid members, and a second plate having a
25 slot mounted on the first surface of the second deformable member and the
second end portion of the rod of the first force applying member mounted in
the slot of the first plate and the second end portion of the rod of the second
force applying member mounted in the slot of the second plate.

30 19. The mold according to claim 1 wherein the strap members are
each elongated members having a flat major surface facing away from the

major surface of the platform and are each a laminate including a spring steel substrate having a high temperature plastic secured to the flat major surface.

20. The mold according to claim 19 wherein the strap members are
5 connected to the first deformable member by a pair of springs and the
opposite end of the strap members are connected to the second bendable
member by a pair of springs.

21. The mold according to claim 19 wherein the ends of the support
10 members are connected to the first bendable member and the second
bendable member by nut and bolt assemblies.

22. In a sheet shaping apparatus of the type having a shaping
station comprising an upper mold, a lower mold and an elevator arrangement
15 to move the upper mold and the lower mold toward and away from one
another, the upper mold comprising a downwardly facing shaped surface,
wherein the improvement comprises:

the lower mold comprising:

- a platform having a major surface;
- 20 a first deformable member mounted on the platform and spaced
from the major surface of the platform;
- a second deformable member mounted on the platform and
spaced from the major surface of the platform and from the first
bendable member;
- 25 a plurality of flexible strap members between the first and
second deformable members and having a space between adjacent
strap members, each support member having one end portion
connected to the first deformable member and the opposite end portion
connected to the second deformable member, and
- 30 a force applying member acting on at least one of the
deformable members to change distance between the major surface of

the platform and a portion of the at least one of the deformable member.

23. The sheet shaping apparatus according to claim 22 further
5 comprising a heating furnace having a conveyor on one side of the shaping station defined as the upstream side of the shaping station and a cooling furnace having sheet conveying system on the other side of the shaping station defined as the downstream side of the shaping station and a transfer station between the shaping station and the cooling furnace

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24. The sheet shaping apparatus according to claim 23 wherein the lower mold further comprises:

a first pair of elongated rigid members each having an end
portion mounted to the first deformable member and the opposite end
15 portion mounted on the platform to position the first deformable member in a spaced relationship to the major surface of the platform, wherein the first pair of rigid members are spaced from one another, and

a second pair of elongated rigid members each having an end
20 portion mounted to the second deformable member and the opposite end portion mounted on the platform to position the second deformable member in a spaced relationship to the major surface of the platform, wherein the second pair of rigid members are spaced from one another.

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25. The lower mold of the sheet shaping apparatus according to claim 24 wherein the force applying member is a first force applying member connected to the first deformable member at a location between the first pair of rigid members, and further comprising a second force applying member
30 connected to the second deformable member at a location between the second pair of rigid members to change the distance between the second deformable member and the major surface of the platform.

26. The lower shaping mold of the sheet shaping apparatus according to claim 25 wherein the first and second deformable members each having first surface facing the major surface of the platform and an opposite
5 surface defined as a second surface, and the first end portion of each of the first pair of rigid members is pivotally mounted to the first surface of the first deformable member, and the first end portion of each of the second pair of rigid members is pivotally mounted to the first surface of the second deformable member.

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27. The lower shaping mold of the sheet shaping apparatus according to claim 24 wherein the force applying member comprises:

a support member mounted between the platform and the first and second deformable members;

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a first pull rod having an end portion connected to the first deformable member at a location between the first pair of rigid members and the other end defined as a second end portion of the first pull rod connected to the support member;

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a second pull rod having an end portion connected to the second deformable member at a location between the second pair of rigid members and the other end defined as a second end portion of the second pull rod connected to the support member, and

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an elevator mounted on the platform to move the support member toward the major surface of the platform to deflect the first and second deformable members.

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28. The lower shaping mold of the shaping apparatus according to claim 27 wherein the first and second pull rods are slideably mounted in the support member, and the support member is captured between the first deformable member and the second end portion of the first pull rod, and the second deformable member and the second end portion of the pull rod.

29. The lower shaping mold of the sheet shaping apparatus according to claim 25 wherein each of the strap members has a first surface facing the major surface of the platform and an opposite surface defined as a second surface and further comprising:

5 at least one wheel in the space between adjacent strap members;

 a shaft interconnecting the wheels with the shaft between the first surface of the strap members and the major surface of the platform, and

10 a displacement system to move the wheels and strap members relative to one another from a first position with portions of periphery of the wheels above the second surface of the strap members to a second position with the periphery of the wheels below the second surface of the strap members.

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30. The lower shaping mold of the sheet shaping apparatus according to claim 29 wherein the shaft and the wheels comprise a first conveying roll, and the first conveying roll is one of a plurality of spaced conveying rolls wherein each of the conveying rolls includes a wheel in the space between adjacent strap members and a wheel on outer side of the outer strap members, and further comprising a motor operatively connected to the plurality of shafts wherein when the motor is energized the shafts and their respective wheels are rotated.

25 31. The lower shaping mold of the shaping apparatus according to claim 30 wherein the displacement system moves the platform to move the strap members from the first position to the second position.

30 32. The lower shaping mold of the shaping apparatus according to claim 31 wherein the shafts of the plurality of conveying rolls are mounted on a support structure and the platform is mounted for movement toward and away from the plurality of conveying rolls.

33. The lower shaping mold of the shaping apparatus according to claim 30 wherein the displacement system comprises a support member between the strap members and the platform and at least one displacement
5 device to move the support member and the shafts of the plurality of conveyor rolls toward and away from the strap members.

34. The lower shaping mold of the shaping apparatus according to claim 33 wherein the support member has a first surface facing the platform
10 and the at least one displacement device is mounted to the platform and to the first surface of the support member wherein the at least one displacement device moves the support member toward and away from the strap members to move the wheels and strap members from the first position to the second position, and the force applying members moves their respective deformable
15 member toward the major surface of the platform.

35. The lower shaping mold of the shaping apparatus according to claim 28 wherein at least one of the conveying rolls is includes a unitary portion of shafts and wheels.
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36. The lower shaping mold of the shaping apparatus according to claim 22 wherein the first and second deformable members are elongated members having a flat major surface and a long axis with the long axis of the first and second deformable members parallel to one another and the plurality
25 of flexible strap members are each elongated members having a flat major surface and a long axis with the long axes of the strap members parallel to one another and normal to the long axis of the first deformable member.

37. The lower shaping mold of the shaping apparatus according to claim 36 wherein at least one of the strap members is a laminate comprising a
30 spring steel substrate having a plastic covering over at least the flat major surface of the at least one strap member.

38. The lower shaping mold of the shaping apparatus according to claim 25 wherein the first and second force applying members each comprise:

a biasing device mounted on the major surface of the platform,

5 and

a rod having first end portion connected to the biasing device and an opposite end portion defined as a second end portion wherein the second end portion of the rod of the first applying member is connected to the first deformable member and the second end of the rod of the second applying member connected to the second deformable member.

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39. The lower shaping mold of the shaping apparatus according to claim 38 wherein the biasing device is selected from the group of electrically powered motors, stepper motors, servomotors, fluid operated cylinders, rack and pinion arrangements and crank mechanisms.

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40. The lower shaping mold of the shaping apparatus according to claim 38 wherein the rod of the first and second applying member is a telescoping rod and further comprising a first plate having a slot mounted on the first surface of the first deformable member between the first pair of rigid members, and a second plate having a slot mounted on the first surface of the second deformable member and the second end portion of the rod of the first force applying member mounted in the slot of the first plate and the second end portion of the rod of the second force applying member mounted in the slot of the second plate.

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41. The lower shaping mold of the shaping apparatus according to claim 22 wherein the strap members are each elongated members having a flat major surface facing away from the major surface of the platform and are each a laminate including a spring steel substrate having a high temperature plastic secured to the flat major surface.

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42. The lower shaping mold of the shaping apparatus according to claim 41 wherein the strap members are connected to the first deformable member by a pair of springs and the opposite end of the strap members are
5 connected to the second bendable member by a pair of springs.

43. The lower shaping mold of the shaping apparatus according to claim 41 wherein the ends of the support members are connected to the first bendable member and the second bendable member by nut and bolt
10 assemblies.

44. The sheet shaping apparatus claim 23 wherein the heating furnace comprises a gas hearth heating furnace, the plurality of flexible strap members lie in a plane having a slope toward conveying wheels mounted at
15 one side of one of the outer strap members of the plurality strap members.

45. The lower shaping mold of the shaping apparatus according to claim 22 wherein the platform has wheels to move the lower mold into and out of the shaping station.
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46. The lower shaping mold of the shaping apparatus according to claim 32 wherein the displacement system is mounted at the shaping station and the platform and the plurality of spaced conveyor rolls are mounted on a transportation device to move the platform and the plurality of spaced
25 conveyor rolls into the shaping station to position the platform over the displacement system and to move the platform and the plurality of conveyor rolls out of the shaping station.

47. The lower shaping mold of the shaping apparatus according to claim 32 wherein the platform, the plurality of spaced conveyor rolls and the
30 displacement system are mounted on transportation device to move the

platform, the plurality of spaced conveyor rolls and the displacement system into and out of the shaping station.

5 48. A method of shaping a sheet comprising the steps of:
 providing a first mold having a pair of spaced deformable
 members and a plurality of spaced flexible strap members between the
 spaced deformable members, each of the strap members having
 opposed end portions connected to adjacent one of the deformable
 members with surface of the plurality of strap members providing a
10 sheet supporting surface;
 providing a sheet on the supporting surface;
 providing a shaped surface over and spaced from the sheet;
 moving the shaped surface and the first mold relative to one
 another to move the shaped surface and the sheet into contact with
15 one another, and
 continuing the practice of the moving step, while
 deforming the deformable members to move the sheet against
 the shaped surface.

20 49. The method according to claim 48 wherein the sheet is a glass
 sheet and the shaped surface is the shaped surface of a vacuum mold and
 further comprising the step of providing a negative pressure in the vacuum
 mold during the practice of at least one of the following steps: the moving
 step, the continuing step and the deforming step to bias the sheet against the
25 shaped surface and further comprising the steps of moving the first mold
 away from the shaped surface while maintaining the sheet against the shaped
 surface by the vacuum.

 50. The method according to claim 49 wherein the providing step
30 comprising the steps of:
 positioning portions of rotating wheels above the sheet
 supporting surface;

displacing the sheet along a path through a heating furnace toward the sheet supporting surface onto the portions of the rotating wheels, and

5 moving the rotating wheels and supporting surface relative to one another to position the sheet on the sheet supporting surface.

51. The method according to claim 50 wherein the moving step is practiced by moving the plurality of flexible strap members and the first and second deformable members toward the shaped surface to move the
10 supporting surface into engagement with the sheet.

52. A shaped sheet made according to the method of claim 48

53. The sheet according to claim 52 wherein the sheet is a glass
15 sheet.

54. The sheet according to claim 53 wherein the sheet is an automotive sidelight.